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CONSERVATION FARMING PRACTICES AND FLOOD CONTROL

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Conservation Farming Practices and Flood Control

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INTRODUCTION

The farmer has a distinct contribution to make to flood control because the use of farm land must play an important part in any comprehensive plan for the prevention and control of flood waters.

Conservation farming practices developed primarily for the prevention and control of soil erosion have given positive indications of wider usefulness. Their value in conserving water in the land has been demonstrated during periods of drought in recent years. Farmers who have applied such practices to their lands are able to obtain normal, or at least more nearly normal crop yields than those farmers who have not utilized rainfall to the best advantage. The same practices which prevent soil erosion and conserve rain water in the soil to relieve farming conditions in times of drought can also make a genuine contribution to flood control.

By slowing down the run-off of rain water in order to curb erosion, the farmer automatically reduces the volume and velocity of water which might otherwise contribute to floods. Similarly, the soil which is held on the land by erosion-control methods is thereby kept out of the streams, where it would reduce the water-carrying capacity of the channels. Thus, when a farmer applies erosion-control measures to his land he is actually contributing to flood control, and when

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a considerable proportion of the farmers of a watershed adopt effective soil- and water-conservation measures on their lands, the effect will be beneficial not only from the standpoint of erosion control, but in reducing the flood hazard downstream. The extent of these latter benefits will depend not only on the physical characteristics of the particular watershed in question, but also on other factors such as the amount and intensity of rainfall and the character of the streams involved.

THE FARMERS' PART IN FLOOD CONTROL

Probably most farmers have viewed the whole difficult problem of flood control as strictly an engineering problem, involving the construction of downstream levees, dams, revetments, and spillways. The possibility that they might play a real part in dealing with flood waters in the major streams has seemed to them remote, yet no one has better cause to be concerned about and participate in flood-control work than the farmer. Floods have exacted from him a dreadful toll in human suffering and property loss. Homes and roads have been swept away, crops ruined (fig. 1), bridges destroyed, livestock drowned, and millions of tons of fertile soil washed out of the fields. Enormous quantities of rain water that should have been stored in the soil for crop use during dry seasons have flowed away as so much waste. The cost has mounted to several hundreds of millions of dollars annually. Farms have suffered even more than business establishments

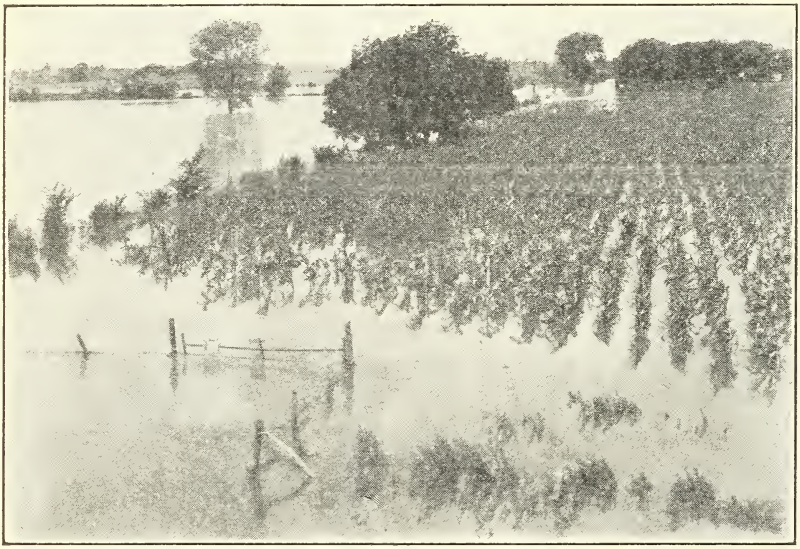

FIGURE 1.—Scenes like this are familiar to many thousands of farmers from whom floods annually exact a dreadful toll in crop and property loss.

and industries of the cities from the destructive effects of uncontrolled run-off and the surge of racing flood waters.

Representing recurrent tragedy, past floods have created a widespread determination to build a permanent, constructive, and complete program of flood control, utilizing every available resource and method of control. The farmer, by proper use of his land, can contribute substantially to the desired end of such a program. Data from erosion experiment stations of the Soil Conservation Service support this point of view.

LAND USE THE REGULATING FACTOR IN WATER RUN-OFF

Studies carried on near Ithaca, N. Y., by the Soil Conservation Service in cooperation with Cornell University, show that during one growing season a single acre of cornland lost as run-off 172,900 gallons (6.37 acre-inches) more water than was lost from an acre of comparable meadowland on another part of the same slope.

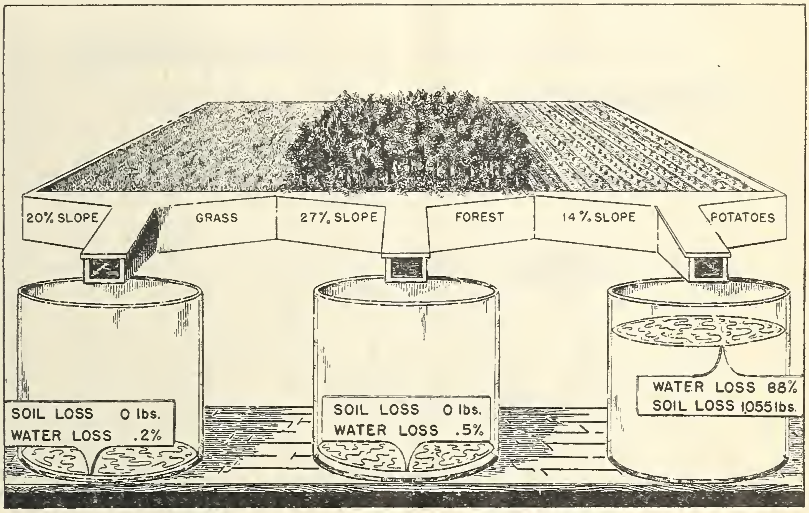

FIGURE 2.—Soil and water losses per acre from land under grass, forest, and crop at the Soil Conservation Experiment Station, Ithaca, N. Y., during the precipitation of 9.47 inches, March 1–19, 1936.

Other measurements (fig. 2) at the Ithaca erosion experiment station during the period from March 1 through March 19, 1936, or just preceding the 1936 flood on the watershed of one of the upper tributaries of the Susquehanna River, are equally indicative of the effectiveness of vegetation in controlling run-off. Water losses from a potato field amounted to 88 percent of the total precipitation, on land having a slope of 14 percent; and soil was lost at the rate of 1,055 pounds per acre. Of 9.47 inches of rain and snow, 8.38 inches was lost as run-off during this critical period. In contrast, the corresponding loss of water from a neighboring forested area, with a slope of 27 percent, was approximately 0.5 percent of the total precipitation. It is interesting that the ground beneath the cover of forest litter was not frozen, whereas that in the potato field was frozen. Still more interesting is the fact that from neighboring grassland, with a slope of 20 percent, the ground of which was not frozen, the run-off was less than 0.2 percent of the total precipitation, and there was no soil loss. Another grassplot, with a 14-percent slope, where the ground was frozen, lost 88 percent of the total precipitation, but even here there was no measurable soil erosion.

GRASS EFFECTIVE IN THE CONTROL OF WATER

At the erosion experiment station at Zanesville, Ohio, on a 12-percent slope, in a section with an annual average rainfall of 34.5 inches, measurements (fig. 3) for a 2-year period showed that 42.5 percent of the total rain and snow falling on bare ground was lost as run-off per year. Where the land was planted continuously to corn, 35.2 percent of the precipitation was lost as run-off, but on the same kind of land where a 4-year rotation of corn, wheat, and 2 years of grass was practiced, the run-off amounted to only 18.4 percent of the total fall of rain and snow. A bluegrass area of exactly the same kind of land lost only 4.5 percent of the rainfall.

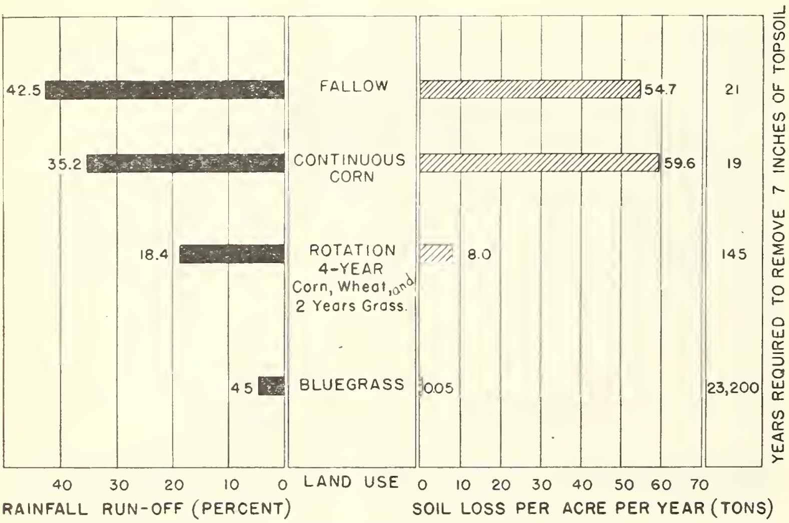

FIGURE 3.—Effects of land use on average annual run-off and soil loss on a 12-percent slope of Muskingum silt loam at Zanesville, Ohio, covering 2-year period 1934–35, under average annual rainfall of 34.5 inches.

Corresponding data on soil losses were also obtained. Fallow land kept bare of all vegetation lost soil at the rate of 54.7 tons a year per acre and land devoted continuously to corn lost soil at the rate of

59.6 tons a year per acre. Where a 4-year rotation was used, however, the annual soil loss was reduced to 8 tons an acre. The prevention of soil loss from land planted to bluegrass was even more striking. Under such protective cover, the annual rate of soil removal by erosion was cut down to the almost insignificant amount of 100 pounds an acre. In other words, the soil loss from cornland of the same slope and the same kind of soil was 1,192 times that from land planted to bluegrass.

According to these measurements, it would require only 21 years to remove 7 inches of topsoil from the bare land, 19 years to remove 7 inches of topsoil from the land planted continuously to corn, 145 years for an equivalent soil removal from the land in crop rotation, and 23,200 years to strip the 7 inches of topsoil from land in bluegrass.

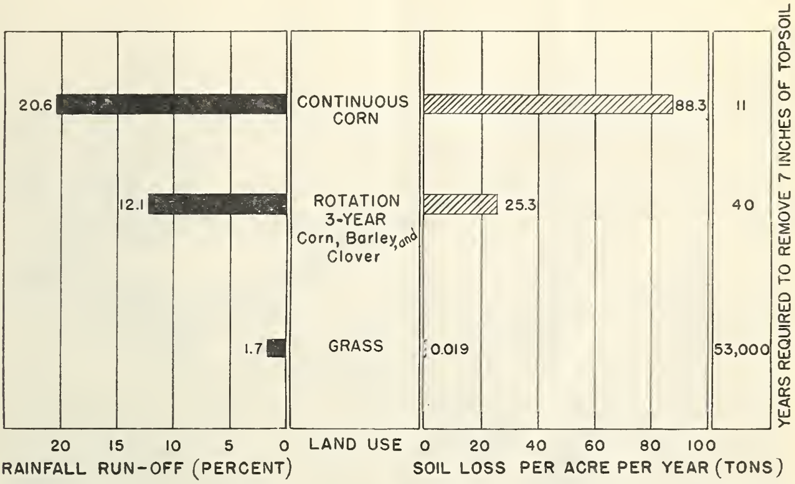

FIGURE 4.—Effects of land use on average annual run-off and soil loss on a 16-percent slope of Clinton silt loam at La Crosse, Wis., covering 3-year period 1933–35, under average annual rainfall of 34.1 inches.

At the La Crosse, Wis., station, measurements (fig. 4) over a 3-year period have shown that 20.6 percent of all the rain (plus snow equivalent of rain) falling on land continuously in corn was lost as run-off. Under a 3-year rotation of corn, barley, and clover, the same kind of land lost 12.1 percent of the total precipitation; but when covered continuously with grass, only 1.7 percent of the water was lost as immediate run-off. The test fields were on a 16-percent slope, and the average annual rainfall was 34.1 inches.

Corresponding soil losses were recorded under the different types of land use. The cornland lost soil at the rate of 88.3 tons an acre per year. The area cropped under a 3-year rotation lost 25.3 tons an acre annually, while the grassland lost only 38 pounds a year. Thus, the soil loss from the cornland was 4,647 times that from grass pastureland.

On the basis of these measurements, it would require only 11 years to remove 7 inches of topsoil, which is about the depth of the topsoil, from the land continuously in corn (fig. 5). To wash away an equivalent depth of soil from the field in rotation would require 40 years, but to remove the same amount of soil from the bluegrass field would require 53,000 years.

The exceedingly slow rate of erosion taking place under grass probably means that the soil is stabilized, or that soil is built up from beneath as fast as it is removed from the surface.

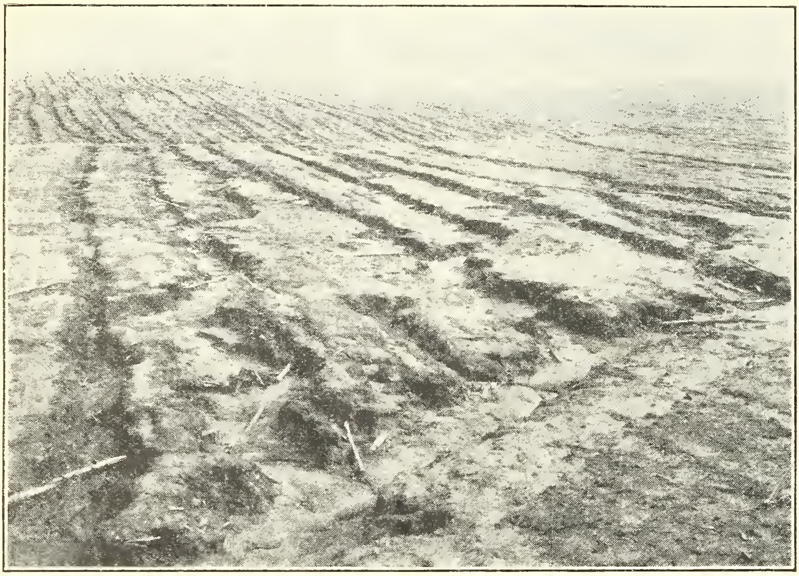

FIGURE 5.—Planting land continuously to corn and cultivating it up and down the slope induces heavy soil losses.

Similar measurements (fig. 6) at the erosion experiment station near Bethany, Mo., on Shelby loam soil occupying an 8-percent slope give further indication of the value of conservation methods in reducing water run-off as well as soil loss. During a 5-year period in which the average annual precipitation was 34.8 inches, 31.2 percent of all the rain and snow falling on fallow land was lost as run-off. Land planted to a mixture of bluegrass and timothy lost only 9.3 percent of the total rainfall. Where a 3-year rotation of corn, wheat, clover, and timothy was used, the water loss in immediate run-off amounted to 15.2 percent of the total precipitation. Land planted continuously to corn lost 28.3 percent of the precipitation.

The annual soil loss from fallow land was 112.8 tons an acre per year; from land in continuous corn, 68.8 tons; from land under rotation, 11.4 tons; and from land in grass, only 0.29 ton. According to these rates, it would take 3,910 years to remove 7 inches of topsoil from the land in grass, 99 years from rotated fields, 16 years from continuous corn, and only 10 years from land kept bare of vegetation.

Measurements from Marshall silt loam on a 9-percent slope over a 3-year period at Clarinda, Iowa, under an average annual rainfall of 26.8 inches, show that the water loss on land planted continuously to corn has amounted to 8.6 percent of the rainfall and snow, along with a soil loss of 18.8 tons per acre annually, and that 48 years would be required to remove 7 inches of topsoil with this type of land use (fig. 7).

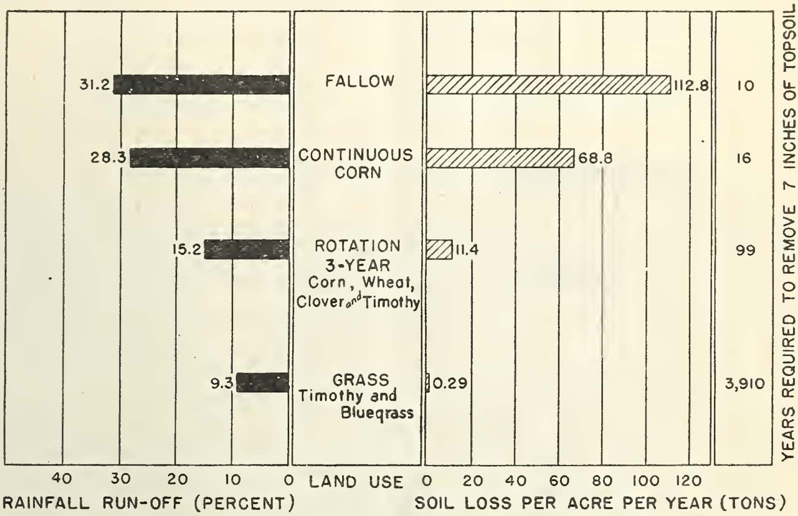

FIGURE 6.—Effects of land use on average annual run-off and soil loss on an 8-percent slope of Shelby loam at Bethany, Mo., during the 5-year period 1931–35, under an average annual rainfall of 34.8 inches.

Under a 3-year crop rotation of corn, oats, and clover, the water run-off amounted to 5 percent of the total precipitation (rainfall and snow) and the average soil loss to 5.4 tons per acre a year. From bluegrass, however, less than 1 percent of the rainfall and snow was lost, and the soil loss was only 0.037 ton per acre annually. An indication of the protective efficiency of this type of vegetative cover, is the fact that approximately 24,600 years would be required to remove 7 inches of topsoil from the field.

DECREASED RUN-OFF AND FLOOD CONTROL

It is significant that the soils at these erosion experiment stations represent extensive soil regions. The Zanesville station is located on the principal agricultural soil found within an area of approximately 78 million acres of the unglaciated Appalachian region; the La Crosse station is located on the main type of farm soil within an area of about 12 million acres in the unglaciated section of southwestern Wisconsin and adjacent Minnesota; the Bethany station is similarly located on the most important soil within an area of about 15 million acres of the glacial region in southern Iowa, northern Missouri, southeastern Nebraska, and northeastern Kansas; and the Clarinda station is on the most representative land of some 25 million acres of the wind-blown or loessial soil of the Missouri River Valley.

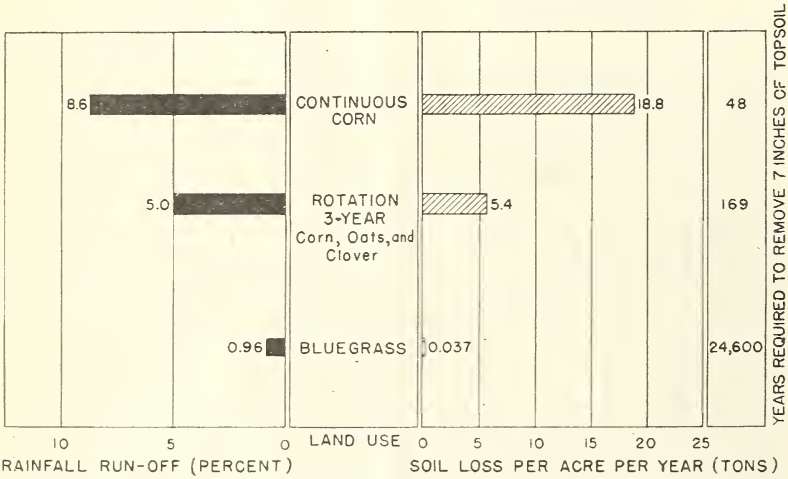

FIGURE 7.—Effects of land use on average annual run-off and soil loss on a 9-percent slope of Marshal silt loam at Clarinda, Iowa, during a 3-year period 1933–35, under an average annual rainfall of 26.8 inches.

In view of the small loss of rain water from land having a good vegetative cover and of the greatly reduced water losses where cropping practices include protective strips of vegetation and other adaptable control measures (fig. 8), it seems logical for the farmer to expect that widespread utilization of conservation farming practices would contribute substantially to the prevention and control of floods.

Except the oceans, there is no reservoir for water so vast and effective as the soil. It is this great reservoir that the farmer can utilize in his contribution to flood control.

A simple illustration is pertinent. When water is spilled from a pitcher onto the surface of a tilted wooden table, the water rushes off immediately and forms a puddle on the floor. But when the hard wooden table is covered with a blotter and then a heavy Turkish towel, most of the water is absorbed; the excess is impeded and spread in its downward flow by the nap of the towel. The same principle applies to the land. When it is bare, the raindrops falling on it rush off into the nearest stream or river, just as the water rushed off the tilted table onto the floor. When the land is covered with rich absorptive topsoil, made porous by the hidden conduits of burrowing earthworms, insects, and the roots of plants, there is a "blotter" for rain. In a similar manner, vegetation, like the nap of the towel, forms countless tiny impediments to the downhill flow of any excess rain water which the soil is unable to absorb.

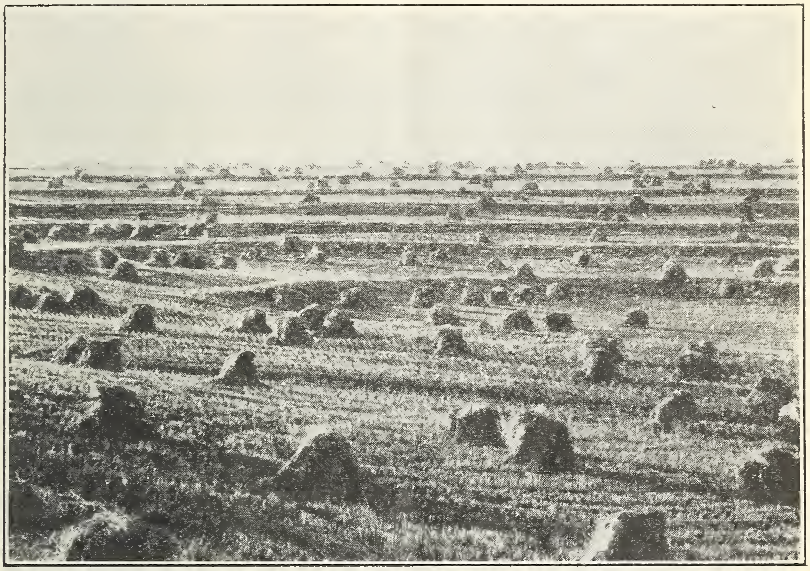

FIGURE 8.—This fertile wheatland was protected from excessive water run-off and erosion by well-built terraces.

When a drop of rain strikes on land covered with a dense blanket of vegetation, it breaks into a spray of clear water which slowly finds its way into the numberless channels that perforate the soil, but when a raindrop strikes bare soil, the force of impact causes fine soil particles to be taken into suspension, and it becomes a drop of muddy water.

As this muddy water begins to sink into the soil, the fine particles filter out at or near the surface and form a thin, muddy film which chokes the pores of the soil. The result is that only a small part of the water can percolate very far into the soil. The other part flows over the surface and downhill into the streams, carrying with it a load of soil in the form of erosional debris (figs. 9 and 10).

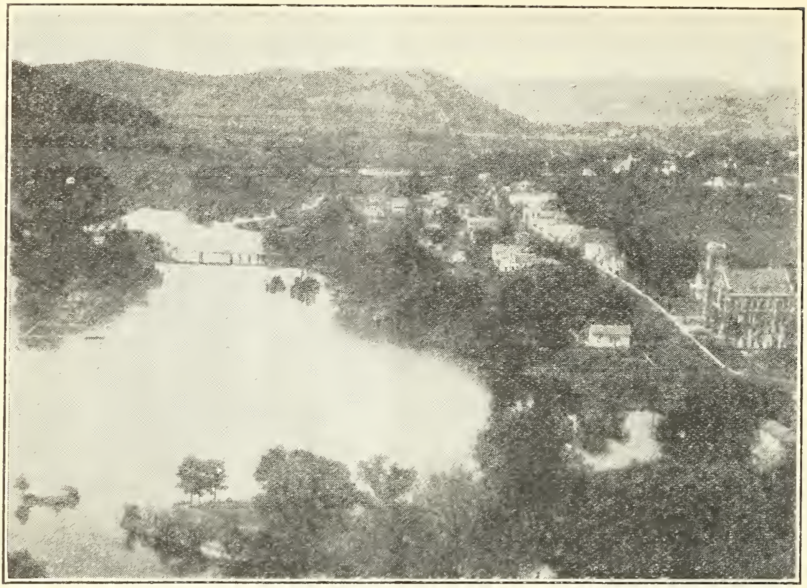

FIGURE 9.—Lake Como at Hokah, Minn., in 1926. The lake has been a famous summer resort for 75 years, having been formed originally to supply water power for a railroad shop and flour mill in 1861. The dirt fill which served as a dam was broken by heavy rains and tremendous floods in 1909. The place remained a dry run until 1922, when a new dam was built and the lake was re-formed.

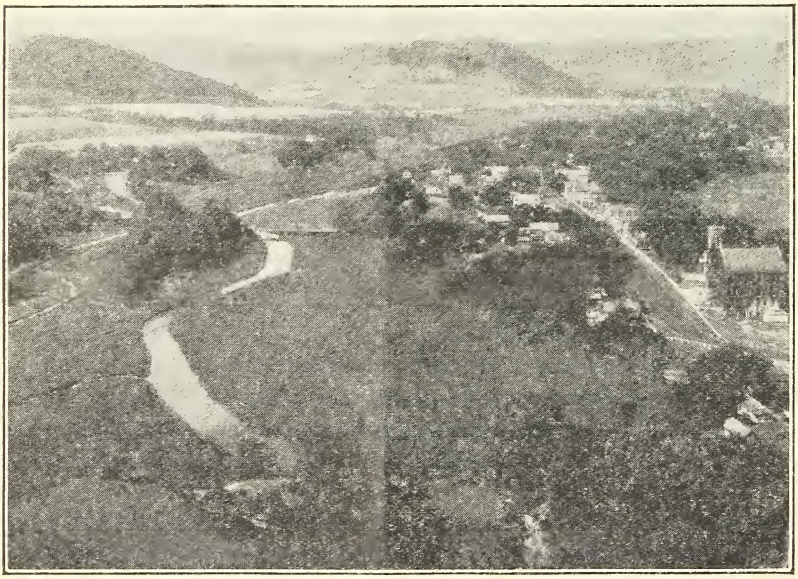

FIGURE 10.—What remains of the former Lake Como, as photographed in July 1936. The lake has become a mud flat overgrown with weeds. Silting has been accomplished very rapidly in the last 10 years due to the cutting of timber and the cultivation of hill slopes in the valleys above.

That is the story of one raindrop falling on bare ground. Multiply that single drop several billion times, and a superficial flow of filmy, soil-filled water has been accumulated. The velocity of the flow accelerates rapidly and erosive power is generated and progressively increased. Soon rampant waters from torrential downpours are tearing away the surface soil from unprotected slopes and piling up in natural depressions of the land or in erosion-made gullies. From these gullies and natural lines of concentrated flow, water is discharged, as from gutters, into the little streams which, when united, pour water with maximum speed into the channels of major streams.

Bare, nonporous, unabsorptive soil without humus, is soil that sheds water swiftly and helps in times of heavy rainfall to raise already-swollen streams to dangerous flood stages.

On the other hand, porous, absorptive, humus-filled topsoil, protected by a cover of vegetation, is soil that absorbs rain water and discharges smaller quantities of it into the streams.

METHODS OF CONTROL FOR EVERY FARMER

For sound economic reasons, a farmer obviously cannot hope to or be expected to maintain all of his land in close-growing grasses and trees. Some of it must be cultivated part of the time in order to produce crops. There are, however, farming methods which will conserve soil and water just as there are other methods which encourage soil and water wastage. Existing evidence points to certain well-established soil- and water-conserving methods as contributing to flood control, particularly where the several adaptable methods are coordinated into unified land-use programs for farm units. This means that each differing piece of land on a farm should be treated in accordance with its particular needs and adaptabilities, and all known practical measures for control and prevention of soil and water wastage utilized.

PROTECTIVE SOIL-BUILDING CROP ROTATIONS

Even though some of the land must be in cultivated crops some of the time, the same land need not be cultivated continuously. Crops may be advantageously rotated from field to field over periods of 2 or more years. For example, where corn is grown this year, oats or wheat may be grown next year, to be followed by clover the third year. In such a rotation, if three fields are used, there is a yearly change of crops on every field that not only conserves soil and water but the fertility of the soil as well. Depending on the section of the country and the crops adaptable to the soils and slopes of that section, there are numerous variations possible in crop rotations.

CONTOUR STRIP CROPPING

Contour strip cropping (fig. 11), or the alternation of strips of clean-tilled crops, like cotton and corn, with similar strips of close-growing crops such as the small grains, legumes, and grasses, is, in itself, a highly effective method of erosion control and water conservation. It provides, moreover, an opportunity for additional protection through the rotation of crops on the same field. Bare soil is exposed between the rows of clean-tilled crops, but there is relatively little bare soil in the strips of close-growing crops. When the soil in the clean-tilled strips fails to absorb the rainfall as fast as it comes down, the surplus, generally loaded with smaller soil particles, runs into the intervening strips of close-growing crops. There, as the movement of the water is slowed down by the close-growing vegetation and the mat of roots in the soil, the water drops much of its soil load and tends to soak into the ground. If the close-growing strips are wide enough and the vegetation dense enough, little or no water flows from the lower side of the strips with close-growing plants. In other words, the protected, close-growing strips between the unprotected, clean-tilled strips act as blotters and strainers to slow down the flow of run-off water and halt the removal of soil.

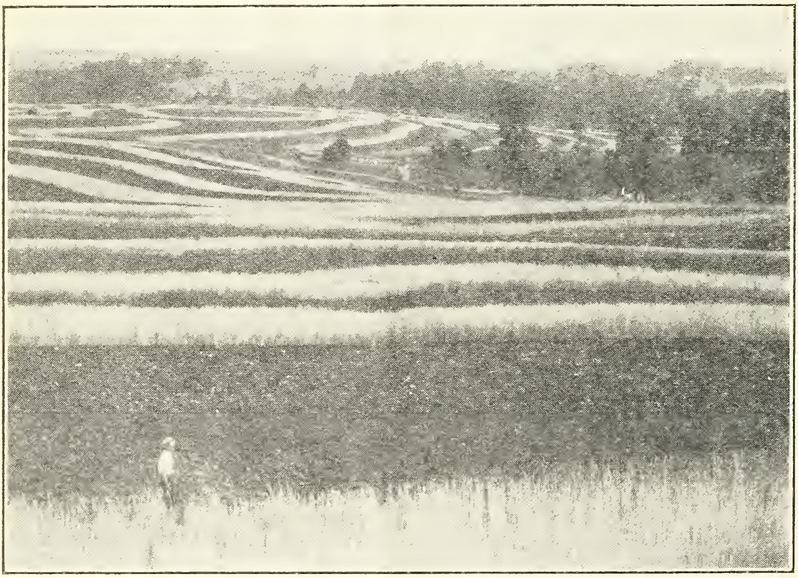

FIGURE 11.—Contour strip cropping in proper rotations, such as shown here, is recommended by the Soil Conservation Service for erosion control and water conservation.

By growing cover crops during the fall and winter on the land that had been partially exposed and planted to clean-tilled crops during the spring and summer, the area of protective, close-growing vegetation is increased and the area of bare, unprotected soil correspondingly decreased.

CONTOUR TILLAGE

In erosion control, contour tillage is a key practice (fig. 12). If a sloping field is plowed, planted, and cultivated around on the contour level instead of up and down the slope, each row and plow furrow acts as an impediment to the downward rush of run-off water. This slows down the velocity of the water and enables more of it to enter the soil, and in turn, diminishes the power of run-off water to carry soil along with it. Where rolling land is tilled up and down the slopes, however, the rows and plow furrows serve as gutters that aid, rather than prevent, soil and water losses. They become man-made channels for the concentration and rapid run-off of water and often develop into gullies which gather and discharge rain water into the streams with maximum speed (fig. 5).

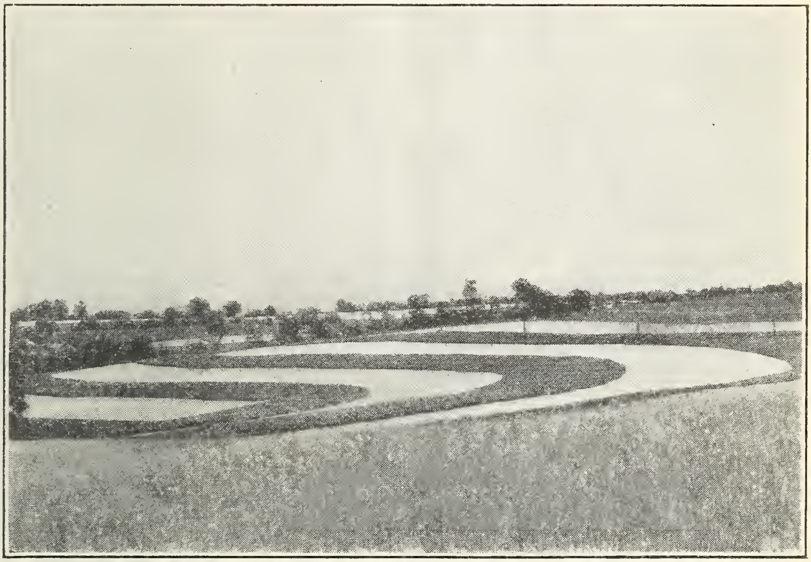

FIGURE 12.—Contour tillage slows down the velocity of water, enables more of it to enter the soil, and thereby reduces soil and water wastage.

SOIL- AND WATER-SAVING TERRACES

In many parts of the country, terracing has proved effective in the conservation of soil and water resources (fig. 13). Terracing is the practice of building ridges of soil, ranging up to about 3 feet in height, along the contour lines of sloping fields in order to slow down and hold as much as possible of the water which would otherwise flow downhill with increasing velocity. Properly constructed terraces, supported by vegetation, control the run-off of rain water to a considerable degree and thus diminish the soil and water losses that would result from the unimpeded movement of water down the natural slopes of fields. Terraces reduce the length of the slope subject to straightaway flowage across entire fields, and prevent to a very important degree the accumulation of water in natural channels, thereby reducing erosion. The water that does not soak into the ground passes slowly, without cutting, along the upper side of the terrace ridge to the side of the field, where it is emptied upon a protected area for safe passage to the nearest stream channel.

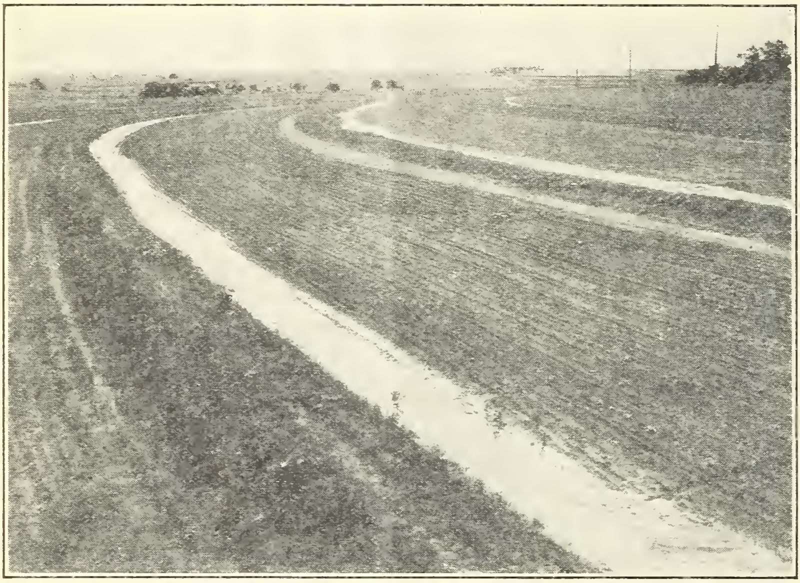

FIGURE 13. Terraces on this field are holding water which otherwise would have been wasted in destructive run-off.

CHECK DAMS AND GRASSED WATERWAYS

Check dams (fig. 14) and grassed waterways (fig. 15) have also proved effective in preventing soil and water losses. Check dams are structures built in water channels and gullies to slow down the movement of water and give it more time to soak into the ground. They also prevent the gullies from growing. There are many types of check dams, and construction is generally both simple and inexpensive. Logs, sod, wire netting, brush, stone, or almost any other available materials may be used effectively according to the size of the channel or gully and the amount of water to be controlled. Many of these dams, especially the larger ones, serve the useful purpose of impounding water for livestock, and in the drier parts of the country

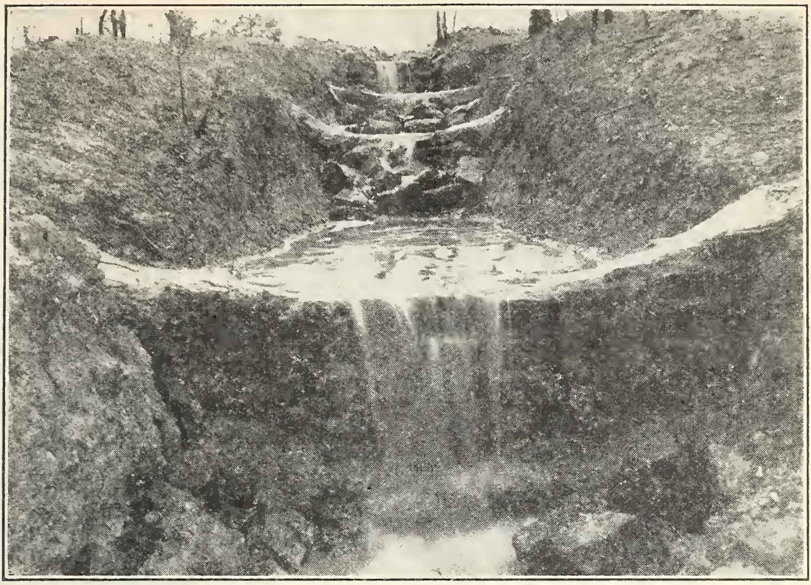

FIGURE 14.—Rubble and rock dams in a gully. These structures built of native stone retard the flow of water and practically nullify its cutting power.

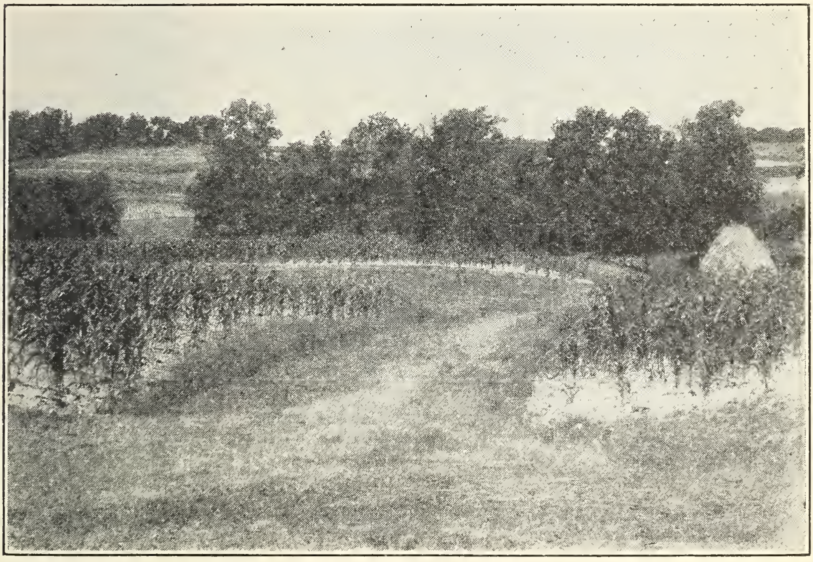

FIGURE 15.—Soil and water wastage may be prevented in natural water channels by planting thick-growing grasses in the watercourse.

water can be taken from them for irrigating small fields and sometimes fairly large fields.

In some cases, soil and water wastage may be prevented in natural drainage channels by planting thick-growing grasses in the watercourse and along the banks, especially where they have been sloped. Such grassed waterways serve as an interwoven barrier of vegetation to the flow of water and the transportation of soil. Active gullies can frequently be controlled with mixtures of grass, legumes, shrubs and trees, or with such vines as kudzu and honeysuckle.

SUMMARY

The conservation farming practices here discussed are a few of those found by experience and investigation to be effective in erosion control and which promise, accordingly, substantial aid to upstream flood control and soil protection. There are numerous other practices, both vegetative and mechanical, applicable under various circumstances and conditions, according to the rainfall, type of agriculture, and character of the land. Experiences of farmers and erosion technicians, and experiments by the States and the United States Department of Agriculture, continue to bring out new developments and improvements in conservation farming technique. In the search for a more complete solution of the flood problem, it is reasonable to consider carefully the possible beneficial effects of a widespread application of such conservation farming practices.

In the last analysis, floods are simply raindrops, infinitely multiplied and concentrated quickly in a single channel. Some of the most effective methods of decreasing run-off and erosion by means of vegetative and mechanical controls have been outlined above. If the farmer by the use of these methods will force this water, or any considerable part of it, to move slowly and evenly into his land through the myriad tiny channels of the soil, it seems reasonable to expect definite progress in the prevention and control of floods.

At the present time the Soil Conservation Service has in operation throughout the country 158 erosion-control demonstration areas and 454 C. C. C. camps where measures of controlling erosion and run-off are being applied. The farmer may learn much by visiting and studying these conveniently located demonstrations. Their locations can be learned from the county agricultural agents or State colleges of agriculture.

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